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Biodiversity characteristics of *Teucrium polium* species in Saudi Arabia



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Abstract *Teucrium* (Lamiaceae) is a large and polymorphic genus distributed mainly in Europe, North Africa and in the temperate parts of Asia. In this study, the anatomical features of the leaf and stem of *Teucrium polium* are investigated. *Teucrium* has 19 taxa in Iran, which mainly grow in the Irano-Turanian region between 700 and 2000 m above sea level. *T. polium* belonging to sect. *Polium*, is a perennial herb growing on Lorestan province. The leaves clearly exhibit xeromorphy due to features such as thick cuticle layer, thick outer epidermal cell wall, high density of trichomes and thick palisade layer of the mesophyll. Anatomical studies on *T. polium* revealed that the stem shares the general characteristics of the Labiatae family. The aim of our approach was to study the morphological and taxonomical parameters for *T. polium* in Saudi Arabia. The results of this study showed that there was no influence of environment on the structure of stomata and trichomes as studying species with *T. polium*. In conclusion our study shows we have studied the geographical distribution of the species in Saudi Arabia and in the world.

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1. Introduction

The genus *Teucrium* L., with about 100 species, is a large genus distributed in Europe, North Africa, and temperate parts of Asia, but mainly in the Mediterranean region (Mabberley, 1997) along with the genera *Stachys* L. (Akçiçek, 2010) and *Sideritis* L. (Güvenç and Duman, 2010). *Teucrium* has 19 taxa in Iran, which mainly grow in the Irano-Turanian region

between 700 and 2000 m above sea level (Rechinger, 1982). The basic sectional arrangement of the genus is based mainly on the calyx and inflorescence types with varying characteristics (Abdollahi et al., 2003). Among them *Teucrium persicum* Boiss is the only one endemic to Iran (Rechinger, 1982). *Teucrium* species are distributed in most regions of Iran i.e. *T. persicum* is present only at elevations of southern regions as a Saharo-Sinidian element, while *T. hyrcanicum* L., which is a hyrcanian element, grows in the north of Iran. Some species, namely *Teucrium polium* L. and *T. orientale* L., are widely distributed in steppe, arid, and semiarid regions (Eshratifar et al., 2011). Saudi Arabia possesses a unique genetic diversity in the form of ecotypes of tree species. The western and south-western regions of the country are rich in native plant flora of cultivated crops and medicinal plants (Anonymous, 1970). Around 300 species of medicinal plants are used in traditional

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medicine in Saudi Arabia. The rural population depends to a greater extent on wild plants for medicines. Traditional medicine in Saudi Arabia is based on herbal remedies and spiritual healing. Herbal medicine regulation in Saudi Arabia was undertaken in 1996 with the issue of a separate law specifically for herbal medicines.

The aim of the present investigation was to study the morphological and taxonomical parameters of *T. polium* species in Saudi Arabia and also to evaluate the variations in the concentrations and distributions of some secondary metabolites and also to determine the antioxidant and free radical scavenging activity.

2. Materials and methods

Plants were collected from samples of different herbariums. These herbariums are from King Saud University (KSU), King Abdul-Aziz University (KAU), King Abdul-Aziz city for science and technology (KACST), National Commission for Wild Life Conservation and Development (NCWCD) and Ministry of Water (RIY) or collected from different localities of Saudi Arabia.

2.1. Study of morphological characters

- (1) Description of morphological and floral characters.
- (2) Measurements of the whole plant.
- (3) Measurement of leaf area.
- (4) Measurement of sepals (calyx) and petals (corolla).

2.2. Study of stomata and trichomes on leaf surface (micro morphology)

Leaves are collected from plant samples of different herbariums.

Dried adult leaves are cut into a fragment of 1 cm (West, 1968) in the middle of the lamina and put into a test tube which contains 10% of nitric acid (HNO_3). The test tube was placed in a water bath at 100 °C for 5–10 min. After cooling the fragment was then transferred into a Petri dish filled with distilled water. Both halves of the cuticular membrane were gently brushed to clean them from any remaining pieces of the mesophyll tissue. The fragment was then placed into a watch glass filled with 5% acetic acid for 30 min. To bleach, the fragment was washed with distilled water and transferred into 50% alcohol for 2 min, alcian blue for 5 min, alcoholic series (50%, 70%, 80%, 90% and 100%) for 2 min in each series and finally in 1:1 solution of absolute alcohol and Histo clear for 2 min and then in Histo clear for 3 s. After dehydration, the fragment was transferred onto a slide greased with Histo clear

and mounted with Canada balsam. The leaf's stomata sculpturing and trichomes were studied with Light Microscope Olympus (CX41RF), and photographed with camera mounted on light microscope (V-TV063XC).

Four species were scanned using Scanning Electron Microscope (SEM). Young leaves (first fully expanded leaf from the tip) and old leaves (third or fourth fully expanded leaf from the tip) were collected from each plant. Plant specimens for SEM using procedures described by McWhorter et al. (1993). Squares of leaves (with approx. 1 mm thickness of underlying tissues) were excised from the plant, using a razor blade, avoiding the midrib areas so as to give a relatively consistent surface. Leaf segments of approximately 20 mm were fixed for 12 h in 4% glutaraldehyde and rinsed three times with distilled water before dehydration in a graded ethanol series. Samples were dried in a critical point drier and were mounted on aluminum stubs using two-sided adhesive carbon tape. The samples were then coated with a thin layer of gold. Scanning was performed in an electron microscope (Jeol JSM 6060) LV. Electron images were recorded using a digital image processor.

3. Results and discussion

3.1. Duration and habitat

Canescent fleecy herbs perennial or annual, white, tomentose or soft and somewhat low, highly aromatic dwarf shrublet, branched from the base with numerous erect, ascending or spreading, according to Daoud (1985), Al-Kahtani et al. (2000), Shalby et al. (1985), Mandaville (1990), Migahid (1996) and Collenette (1999) (Table 1).

3.2. Stem

Stems are rigid, branched at base, with soft spreading hairs 10–40 cm long, as stated by Batanouny (1981), Mandaville (1990) and Migahid (1996) (Plate 1).

3.3. Leaves

Leaves are sessile and simple, oblong-linear, spatulate, crenate margin and obtuse apex, opposite blade, shorter than flowers 10–15 mm long, 3–5 mm wide, crenulated at least in upper half, strongly revolute. They are of tomentose surface similar to that reported in Daoud (1985) Mandaville (1990) and Al-Kahtani et al. (2000) (Table 2).

3.4. Inflorescences and flowers

Flower bisexual, inflorescences terminal and corymbose, or sub terminal and axillary; racemose or head-like, flowers

Table 1 Duration, habitat and morphological characters of stem of *Teucrium polium* species in Saudi Arabia.

Species	Characters														
	Duration		Habitat			Stem									
						Orientation				Defence					
	Perennial	Annual	Herb	Shrub	Shrublet	Twining	Prostrate	Erect	Climb	Glabrous	Tomentose	Canescent	Pubescent	Woody	
<i>Teucrium polium</i>	+	+	+	-	+	-	-	+	-	-	+	+	-	-	

Table 2 Morphological characteristics of leaves of *Teucrium polium* species in Saudi Arabia.

Species	Characters																		
	Blade									Arrangement			Leaf surface			Attachments			
	Apex shape			Shape			Margin			Rolled	Entire	Crenate	Alternate	Opposite	Scabrid hairy	Tomentose	Glabrous	Petiolate	Sessile
	Obtuse	Acute	Triangular– ovate	Oblong– linear	Elliptical	Spatulate	Linear-lanceolate												
<i>Teucrium polium</i>	+	–	–	+			+	–		+	–	–	–	+	–	+	–	–	+

Table 3 Floral characteristics of *Teucrium polium* species in Saudi Arabia.

Species	Characters																
	Inflorescence							Flower		Calyx			Corolla				
	Type				Flower attachment			Unisexual	Bisexual	Shape			Color				
	Axillary	Solitary	Terminal	Corymbose	Racemose	Pedicellate	Sessile			Lanceolate	Campanulate	Oblong-ovate	Yellow	Deeply lobed	Yellow	White	Blue
<i>Teucrium polium</i>	–	+	+	–	–	–	+	–	+	–	+	–	+	+	+	–	+

l-many in axillary verticillate cymes or terminal racemes flowers many together in dense spherical to ovate, short peduncled terminal heads: bracts linear-spatulate, shorter than flowers, sessile c. 12–15 mm in diameter in flat heads that become cone shaped with age; aromatic, calyx c. 4 mm tubular-campanulate, equally deeply 5-lobed, sub sessile, white-tomentose, teeth 5, triangular, tube, locoes, ovate, acute or obtuse teeth which are all nearly equal and about half as long as the tube, corolla deciduous, blue or white, 5-lobed, usually included, naked to densely bearded within, limb bilabiate but upper lip very short, lower lip conspicuous and spreading, with small lateral lobes, white, or cream, woolly, somewhat longer than calyx c. 7–8 mm long very pale pinkish, yellowish in throat, stamens 4 fertile, didynamous inserted near apex of corolla tube, hardly exerted anthers bilocular, cells divergent or divaricate at maturity, scarcely exerted, style bifid, stigmas 2-lobed, according to Batanouny (1981), Daoud (1985), Shalby et al. (1985), Mandaville (1990), Migahid (1996), Collenette (1999) and Al-Kahtani et al. (2000) (Table 3) and Plates 1 and 2.

T. polium (Labiatae) is a wild growing flowering plant and is found in south western Asia (KSA) and Europe. The study of morphology is reported by Mooney and Parsons (1973), Parsons (1976), (Fahn (1988), Christodoulakis and Bazos (1990), Christodoulakis and Fasseas (1991), Fahn and Cutler (1992), Ascensa-o et al. (1999), Corsi and Bottega (1999), Sacchetti et al. (1999), El Oualidi et al. (2002).

It is used in Iranian folk medicine for treating many diseases such as abdominal pain, indigestion, common cold, diabetes, and urogenital diseases and this plant has been reported to have hypolipidemic, antinociceptive and anti-inflammatory (Rasekh et al., 2001; Esmaili and Yazdanparast, 2004; Abdollahi et al., 2003; Tariq et al., 1989, effects. *T. polium* has been reported for its relatively safe nature as medicinal herb (Starakis et al., 2006). All *Teucrium* species are considered as potential source of diterpenoidal compounds (Avula et al., 2003; Bruno et al., 1989; Bruno et al., 2002; Hassan et al., 1979). Anti-cancer chemo sensitizer effects of unique diterpenoids were reported by several researchers Corea et al. (2004), Michaelis et al. (2000), Shalinsky et al. (1993). In a previous communication, hepatotoxicity associated with the hypoglycemic effects of *T. polium* or polygermander was reported and the literature on this herb was extensively reviewed (Zal et al., 2001). It is available in essential oils, pharmaceutical properties, and the effects of herbal remedies containing *T. polium* and *Teucrium. capitatum* (Starakis et al., 2006; Ardestani et al., 2008; Shariffar et al., 2009; Dourakis et al., 2002).

Species belonging to the genus *Teucrium* have been shown to contain different classes of compounds such as fatty acid esters, diterpenes, monoterpenes, sesquiterpenes, flavonoids and polyphenolics (Fonta et al., 1999; Mini et al., 1991; Cozzani et al., 2005; Harborne et al., 1986; Rizk et al., 1986; Uma et al., 2000).

Flavonoids that have been isolated from *T. polium* species include cirsimaritin, cirsilinol, cirsilinol, 5-hydroxy-6,7,3',4'-tetramethoxyflavone, salvigenin, apigenin 5-galloylglucoside, apigenin-7-glucoside, vicenin-2- and luteolin-7-glucoside (Esmaili et al., 2004; Harborne et al., 1986; Kadifkova et al., 2005). The antioxidant potential of cirsimaritin and apigenin-7-glucoside has been indicated (Cuvelier et al., 1994).

Polyphenolic compounds have also shown strong antioxidant activity (Kadifkova et al., 2005), the positive effects of

these antioxidant components come from their ability to inhibit lipid peroxidation and chelate redox-active metals (Marchand, 2002). There is evidence that flavonoids have anti-phosphodiesterase activity and could thus elevate intracellular levels of cyclic nucleotides (Abdollahi et al., 2003).

It is considered to be of great pharmaceutical importance and most were referred and used for medical purposes since the ancient times. Dioscorides (77 AD), traditionally used in folk medicine: febrifuge, stomachic, vermifuge. Infusion of tender parts is used in stomach and intestinal troubles. The plant is also used in steam bath to treat cold and fever (Mossa et al., 2000).

This study provides a chemotaxonomic significance of the studied plant species collected from various catchment areas in Saudi Arabia on the basis of evidence from morphometric and phytochemical studies. Our study concludes that, we have studied the geographical distribution of the species in Saudi Arabia and in the world.

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